Preparation of CBD buccal films with the use of liquid-crystal display (LCD) 3D printer

Chrystalla Protopapa[1], Angeliki Siamidi[1], Dennis Douroumis[2], Marilena Vlachou[1]

[1] School of Pharmacy, Department of Pharmacy, Section of Pharmaceutical Technology, National and Kapodistrian University of Athens, Athens, Greece.

[2] School of Pharmacy, Department of Pharmacy, Section of Engineering and Science, University of Greenwich, Medway Campus, Chatham Maritime, United Kingdom

Background: Amongst the cannabis derivatives, the versatile compound, cannabidiol (CBD), is in the spotlight today, due to its potential health benefits. CBD has garnered attention for its purported ability to alleviate chemotherapy-induced nausea, boost appetite, mitigate pain, and manage seizures. Moreover, research suggests that it could reduce inflammation, hinder cancer cell growth, and improve patient survival rates. Beyond its anti-cancer properties, CBD shows promise in addressing various ailments, such as osteoarthritis, the Alzheimer's disease, and schizophrenia. CBD oil is the primary form of administration, known for its rapid absorption. When taken sublingually, it bypasses the digestive system, offering quick relief—ideal for conditions, like anxiety or acute pain. Despite its advantages, some patients may find the taste unpleasant or feel uncertain about dosing accuracy with droppers. As a result, a solid option of administration has been developed in the form of buccal films. Each of the developed film, presented herein, contains 5 mg of CBD.

Methods: Buccal films of CBD were developed with the use of liquid-crystal display (LCD) 3D printer. The drug was added in the form of CBD oil and specifically mastic oil with 16 mg in each drop. The excipients used were polyox, PEG200, tween 80, H_2O, PEGDA700 and Labrasol ALF. A digital 3D model of the buccal films is created using a computer-aided design (CAD) software. The buccal films were printed in two different sizes 16x30x0.1mm and 24x35x0.1mm. The printer utilizes a liquid crystal display (LCD) screen. This screen acts as a mask, displaying each layer of the object to be printed. After one layer is solidified, the build platform moves slightly downward, and this process is repeated. The LCD screen displays the next layer, and the light selectively cures the formulation to form the next layer of the film. This layer-by-layer process continues until the entire buccal film is formed. Once the film is printed layer by layer, it is removed from the printer. The printed film is then washed with isopropanol to remove any excess formulation. Afterwards, the film was undergone a curing process to ensure that the material was fully solidified. The dissolution experiments on the buccal CBD films were conducted in a USP II apparatus at a pH 6.8 aqueous media, in order to simulate the pH of the oral mucosa. The samples were withdrawn every 40 sec, and analyzed, using a UV-Vis spectrophotometer (λ_{max}=209 nm).

Results: In order to compare the dissolution profiles of the printed formulations, graphs of the percent drug release *vs.* time were constructed. The results indicated that CBD was immediately released. Specifically, from both sizes of the buccal films the drug was released quantitatively, at t=6 min. It is interesting to note that between the two sizes of the films there was a difference in release. Specifically, from the films with the larger size, a 40s faster release of CBD was observed, compared to the smaller size. This is attributed to the fact that when the surface area/volume ratio increases, the release of the active substance also increases.

Conclusions: CBD buccal films of different sizes were prepared by an LCD 3D-prinrer. Immediate release of CBD from the printlets, was noticed irrespectively of the size of the films. However, CBD from the films with higher surface area/volume ratios, was released 40s faster than from their smaller congeneric films.